REGULATORY GUIDE

G-121

RADIATION SAFETY IN EDUCATIONAL, MEDICAL AND RESEARCH INSTITUTIONS

Published by the
Atomic Energy Control Board
May 2000

Atomic Energy Control Board | Commission de contrôle de l'énergie atomique

Canada

REGULATORY DOCUMENTS

The Atomic Energy Control Board (AECB) operates within a legal framework that includes law and supporting regulatory documents. Law includes such legally enforceable instruments as acts, regulations, licences and directives. Regulatory documents such as policies, standards, guides, notices, procedures and information documents support and provide further information on these legally enforceable instruments. Together, law and regulatory documents form the framework for the regulatory activities of the AECB.

The main classes of regulatory documents developed by the AECB are:

Regulatory Policy: a document that describes the philosophy, principles and fundamental factors used by the AECB in its regulatory program.

Regulatory Standard: a document that is suitable for use in compliance assessment and describes rules, characteristics or practices which the AECB accepts as meeting the regulatory requirements.

Regulatory Guide: a document that provides guidance or describes characteristics or practices that the AECB recommends for meeting regulatory requirements or improving administrative effectiveness.

Regulatory Notice: a document that provides case-specific guidance or information to alert licensees and others about significant health, safety or compliance issues that should be acted upon in a timely manner.

Regulatory Procedure: a document that describes work processes that the AECB follows to administer the regulatory requirements for which it is responsible.

Document types such as regulatory policies, standards, guides, notices and procedures do not create legally enforceable requirements. They support regulatory requirements found in regulations, licences and other legally enforceable instruments. However, where appropriate, a regulatory document may be made into a legally enforceable requirement by incorporation in an AECB regulation, a licence or other legally enforceable instrument made pursuant to the *Atomic Energy Control Act*.

100-06533/

REGULATORY GUIDE

G-121

Radiation Safety in Educational, Medical and Research Institutions

Published by the
Atomic Energy Control Board
May 2000

NOTICE

On March 20, 1997, Bill C-23, the *Nuclear Safety and Control Act* (*NSC Act*), received Royal Assent. New regulations that are derived from this Act will become law and replace the existing regulations. Regulatory Guide G-121 references the present *Atomic Energy Control Act*.

Radiation Safety in Educational, Medical and Research Institutions
Regulatory Guide G-121

Published by the Atomic Energy Control Board

© Minister of Public Works and Government Services Canada 2000

Extracts from this document may be reproduced for individual use without permission provided the source is fully acknowledged. However, reproduction in whole or in part for purposes of resale or redistribution requires prior written permission from the Atomic Energy Control Board.

Catalogue number CC172-10/2000E
ISBN 0-662-28889-0

Ce document est également disponible en français.

Document availability

The document can be viewed on the AECB Internet website at *www.aecb-ccea.gc.ca*. Copies may be ordered in English or French using the contact information below:

Communications Division
Atomic Energy Control Board
P.O. Box 1046, Station B
280 Slater Street
Ottawa, Ontario K1P 5S9
CANADA

Telephone: (613) 995-5894 or 1-800-668-5284 (Canada only)
Facsimile: (613) 992-2915
E-mail : info@atomcon.gc.ca

TABLE OF CONTENTS

ACRONYMS IV

PREFACE V
Nuclear regulation and legislation V
Purpose V
Scope V

1. Background 1

2. Developing radiation protection programs 1
2.1 Justification for programs 1
2.2 Regulatory process and application of this guide 2
2.3 Safety and management framework 2

3. Responsibilities for radiation safety 3
3.1 Division of responsibilities 3
3.2 Responsibilities of licensees and managers 5
3.3 Composition and duties of Radiation Safety Committees 6
3.4 Qualifications and duties of Radiation Safety Officers 7

4. Facilities and equipment 11
4.1 General 11
4.2 Designing and designating laboratories 11
4.3 Measuring and limiting radiation 11
4.3.1 Safety equipment 12
4.3.2 Emergency supplies 12
4.3.3 Monitoring provisions 13

5. Radiation safety procedures 14
5.1 General 14
5.2 Developing and administering radiation safety procedures 14
5.3 Content of radiation safety procedures 15
5.3.1 General 15
5.3.2 Specific 16

REFERENCES 22

ACRONYMS

AECB	Atomic Energy Control Board
ALARA	As Low As Reasonably Achievable
ARW	Atomic Radiation Worker
RSC	Radiation Safety Committee
RSO	Radiation Safety Officer

PREFACE

Nuclear regulation and legislation

The Atomic Energy Control Board (AECB) is the federal regulatory agency that currently assures that nuclear facilities and activities do not pose undue risk to health, safety, security or the environment.

At the time of release of this document, the AECB operates under the authority of the *Atomic Energy Control* (AEC) *Act* and its regulations. Under this legislation, educational, medical and research institutions that wish to use radioactive materials may apply for an AECB license by submitting an application that includes the information specified in section 7 of the *AEC Regulations*.

The *AEC Act* and regulations are soon to be replaced by the *Nuclear Safety and Control Act* and new regulations. When the new laws come into force, the AECB will become the Canadian Nuclear Safety Commission, with continuing responsibilities for regulation of nuclear facilities and activities, including the use of radioactive materials at educational, medical and research institutions. At that time, this guide will be updated as necessary to reflect the new legislation.

Since radiation safety is only one aspect of occupational health and safety, AECB licensees must also comply with any other relevant legislation.

Purpose

This regulatory guide is intended to help educational, medical and research institutions design and implement radiation protection programs that meet regulatory requirements.

Scope

This guide applies to educational, medical or research institutions that require a licence from the AECB to possess or use radioactive materials[1]. It describes programs, (hereinafter, radiation protection programs) to assure that radioactive materials are used safely during licensed activities.

---

[1] Includes radioisotopes that are defined to be prescribed substances under the *AEC Act* and regulations.

1. Background

In 1992, the Atomic Energy Control Board (AECB) issued Consultative Document C-121, *Requirements for a Radiation Safety Program for Consolidated Licences*, for public comment. Responses were received from professional associations, licensees, consultants and advisory committees. Their comments focussed on the perceived prescriptiveness of the document, the relative roles of managers and radiation safety committees, and the need for similar guidance for other licensees.

After considering public comments on document C-121, AECB staff drafted a revision entitled *Requirements for a Radiation Safety Program for Radioisotope Licensing*. This draft was discussed during an October 1994 workshop on radiation safety issues. Participants from hospitals, universities, government agencies, private research organizations, radiation protection services, consulting companies and radioisotope users and suppliers provided feedback on this initial revision and related issues.

In October 1997, the AECB issued Consultative Document C-121, Revision 1, *Radiation Safety in Educational, Medical and Research Institutions*. This revision, which addressed all licensed uses of radioactive materials in educational, medical and research institutions, was distributed to some 800 potential users and interested parties for their reviews and comments.

This regulatory guide, G-121, issued under the authority of the *AEC Act* and regulations, takes the comments received on C-121, Revision 1 into account.

2. Developing radiation protection programs

2.1 Justification for programs

Section 7 of the *AEC Regulations* requires that applications to the AECB requesting licences to possess or use a "prescribed substance" include specific information, including such of the following as the AECB may require:

" (a) the nature and quantity of the prescribed substance and the purpose for which it is required;
(b) the maximum quantity of the prescribed substance likely to be required at any one time for the purpose set out in the application;
(c) a description of the premises in which the prescribed substance is to be located and of any equipment in connection with which it is to be used;
(d) a description of the measures to be taken to prevent theft, loss, or any unauthorized use of the prescribed substance;

(e) a description of the measures to be taken, including any plan in case of accident, to prevent the receipt by any person of a dose of ionizing radiation in excess of any dose specified in respect of such person in Schedule II;
(f) a description of the method of disposing of the radioactive prescribed substance;
(g) a description of the qualifications, training and experience of any person who is to use the prescribed substance; and
(h) any other information necessary to evaluate the application."

2.2 Regulatory process and application of this guide

Typically, an applicant for an AECB licence proposes to implement a particular radiation safety program to address the above requirements. The application, including the proposed program, describes how the applicant will ensure that licensed activities are conducted safely. If the information submitted is complete, and demonstrates that the applicant has provided adequately for the safety of workers and the public, the law allows the AECB to issue a licence that authorizes the proposed activities.

This regulatory guide is designed to assist educational, medical and research institutions in the development of programs and the operation of their facilities in order to satisfy radiation safety requirements under the *AEC Act* and regulations.

The following discussions focus on the broad goals, principles and approaches that the AECB considers generally appropriate to address radiation safety concerns at educational, medical and research institutions.

The AECB assesses licence applications and licensed activities on a case-by-case basis. Accordingly, it considers the appropriateness of radiation safety measures within the context of the respective circumstances, and takes into account the views and proposals of licence applicants and licensees concerning their individual situations.

2.3 Safety and management framework

Educational, medical and research institutions that use radioactive materials can best ensure radiation safety by implementing radiation protection programs that are customized to address their individual situations.

If safety is to be assured during the use of radioactive materials at an institution, the senior managers of the institution must provide the infrastructure needed in order to create, implement, enforce and maintain an effective radiation protection program.

The fundamental elements of all radiation protection programs are people, plant and procedure; that is, qualified and committed personnel are needed to develop and

administer all radiation protection programs. In order to succeed, these persons must be empowered with adequate authority and supported by adequate resources. These resources — the plant component of the radiation protection programs — consist of the monetary and physical resources, such as facilities and equipment, that are required for developing, implementing, and maintaining the program. Additionally, all radiation protection programs must include procedures that inform and direct persons who use or oversee the use of radioactive materials.

Accordingly, all radiation protection programs proposed by educational, medical and research institutions that wish to use radioactive materials should consist of a combination of the core elements that is appropriate to the respective situation.

Institutions that wish to engage in complex or large-scale usage of radioactive materials may require more comprehensive radiation protection programs than simpler operations. For example, where the proposed activities are to involve the use of radioactive materials that could be easily dispersed, such as open-source, unsealed or liquid media, the corresponding radiation protection program would typically include measures or contingencies to minimize the occurrence and spread of radioactive contamination.

Conversely, when the proposed activities are to involve only sealed materials, such as radioactive materials encapsulated in sealed sources or solids, a lesser emphasis on spill prevention or contamination control might be appropriate.

3. Responsibilities for radiation safety

3.1 Division of responsibilities

Educational, medical and research institutions can best ensure radiation safety if all levels of the organization — managers and workers — contribute constructively. The respective contributions of these persons in individual situations will depend upon regulatory requirements and the responsibilities of workers as mandated by corporate decisions and structures.

To be licensable under the law, licence applicants must be legal entities, such as corporations, partnerships or individuals. Once licensed, these entities must ensure that they and the activities under their control comply with licence conditions and regulations. Accordingly, the licences that the AECB grants to educational, medical or research institutions are issued to the respective corporations, and not to their departments or employees.

Educational, medical and research institutions typically assign to senior managers overall corporate responsibility for regulatory compliance and radiation safety matters. In turn,

these managers usually delegate routine responsibilities for the day-to-day administration and enforcement of radiation safety to suitably qualified staff. However, notwithstanding any such delegation, managers remain legally responsible for the institution's compliance with regulatory requirements.

Accordingly, managers should ensure that any staff who have been assigned responsibilities for routine administration of radiation safety matters act effectively. Managers should encourage positive job performance by establishing adequate communication, reporting and supervision links with the staff involved. Managers must provide the authority as well as the physical and financial resources required to do the job. To reflect the importance of radiation safety, key staff such as the Radiation Safety Officer should report directly to a senior manager with adequate authority and resources.

Radiation Safety Officer (RSO) is the title commonly assigned to a radiation safety specialist who administers a radiation protection program on a day-to-day basis.

To be effective, RSOs must demonstrate the competence in radiation safety matters that their job responsibilities demand. This competence is usually attained by an appropriate combination of formal training and practical work experience. Typically, RSOs are staff members who function relatively independently on a daily basis, but are ultimately accountable to senior managers for their job performance.

Radiation Safety Committee (RSC) is the title commonly given to a group that collectively provides advice or direction on radiation safety matters.

RSCs are usually established or retained with the approval of senior managers. Members, who may be assigned by managers or otherwise appointed, typically include representatives of workers as well as radiation safety specialists such as RSOs and physicians.

An RSC may have corporate responsibilities for radiation safety, or it may simply have an advisory or evaluation role.

Since educational, academic and research institutions use radioactive materials to varying extents, the qualifications and experience required of the personnel who administer and enforce radiation protection programs at these institutions will vary accordingly.

Whether or not a particular institution retains an RSO or an RSC, its workers should exercise and demonstrate appropriate individual and collective respect for radiation safety. Regulatory requirements, corporate procedures and self-interest should oblige or encourage individuals to handle and use radioactive materials safely.

3.2 Responsibilities of licensees and managers

To obtain an AECB licence to possess and use radioactive materials, applicants must demonstrate that the proposed activities will be conducted safely in accordance with regulatory requirements. When the applicant or licensee is an organization, such as an educational, medical or research institution, these assurances of safety and compliance with legislation are typically provided by senior management. Similarly, after such an organization receives an AECB licence, its senior management continues to be responsible for ensuring that workers comply with licence conditions and regulations.

Managers at educational, academic and research institutions have responsibilities for assuring the safety of staff, workers and the public during the conduct of licensed activities. Accordingly, managers at all levels should strive to promote a positive safety cultures within the workplace, and the organization at large. By promoting, implementing and enforcing appropriate policies, programs, practices, procedures and controls, managers can demonstrate both personal and corporate commitments to conventional and radiation safety in the workplace.

In order to achieve and maintain adequate standards of workplace safety in educational, academic and research institutions that use radioactive materials, the senior management of the institutions must provide any essential human, physical and financial resources. For example, senior managers of such institutions typically retain and assign persons to oversee and ensure radiation safety on a daily basis. These persons must be competent in radiation safety matters, and typically are radiation specialists such as RSOs, RSCs , or medical or research advisers. Senior managers should ensure that their institutions' radiation safety specialists are not assigned competing duties or priorities that might detract significantly from their ability or availability to participate in or to supervise radiation safety matters.

Ideally, an institution's radiation protection program should be funded by monies that are isolated and protected from competing demands.

To summarize, the typical responsibilities of managers of educational, medical and research institutions, or their delegated radiation safety specialists, are to:

(a) submit, as required to support any application for a licence from the AECB, a description of the qualifications, training and experience of any person who is to use, or to oversee the use of, radioactive materials, and a description of the measures to be taken to ensure radiation safety (i.e., the proposed radiation protection program) during the proposed activities;

(b) implement, in accordance with the institution's licence to possess and use radioactive materials, any radiation protection program accepted by the AECB;
(c) authorize any persons identified pursuant to (a) above and accepted by the AECB to perform their duties;
(d) designate RSOs or RSCs where required or appropriate, pursuant to (b) above;
(e) provide the persons who are to ensure radiation safety during licensed activities with written descriptions of their job-related responsibilities and authorities, including any not related to radiation safety;
(f) retain a competent physician to provide medical advice and services if the institution uses radioactive materials to diagnose, examine or treat persons;
(g) encourage effective communications regarding radiation safety amongst managers, staff and workers;
(h) provide and allocate sufficient resources to implement and maintain effective radiation protection programs;
(i) monitor the effectiveness of radiation protection programs;
(j) correct significant deficiencies in radiation protection programs when such deficiencies are detected;
(k) report significant events to the AECB and other agencies as required by regulations and licence conditions;
(l) initiate, undertake or coordinate investigations to determine the cause of significant events, as required to mitigate situations or to prevent future incidents or effects.

3.3 Composition and duties of Radiation Safety Committees

RSCs should include members selected or appointed because of their expertise or stake in radiation safety matters. Collectively, these members should advise their managers and RSOs on radiation safety matters in general, and the effectiveness of radiation protection programs within the organization in particular.

The members of RSCs may participate full- or part-time. They may include radiation safety specialists, such as RSOs and physicians, and representatives of corporate interest groups, such as managers, workers, or specific user units.

The size, membership and terms of reference of any RSC created at a particular educational, medical or research institution will depend upon individual circumstances, such as management decisions, corporate procedures, available resources, licence requirements, or the magnitude, diversity or complexity of the licensed activities.

As authorized by managers, RSCs may:

(a) oversee the radiation protection program and radiation safety matters on behalf of managers;

(b) advise managers and RSOs on radiation safety matters, including the safe use of radioactive materials during licensed activities;
(c) review proposed or existing corporate radiation protection programs and procedures to determine whether they assure that radiation exposures will comply with regulatory limits and will be As Low As Reasonably Achievable (ALARA), social and economic factors taken into account [Reference 5];
(d) review all proposed uses of radioactive materials, and their proposed locations of use, to determine whether these proposals comply with corporate procedures and regulatory requirements;
(e) assess the adequacy, in terms of the contents and schedules for delivery, of the institutions' programs to train persons in the safe use of radioactive materials [Reference 6];
(f) assess the results, and determine the effectiveness, of the institution's programs to train persons in the safe use of radioactive materials [Reference 6];
(g) review the results of internal inspections of facilities, premises, equipment and work practices that assess whether radioactive materials are used safely in licensed activities;
(h) review annual summaries of the occupational radiation exposures received by persons, to determine whether these exposures respect the ALARA principle of dose limitation;
(i) review reports concerning any incidents or unusual occurrences at the institution that involved radioactive materials;
(j) recommend corrective measures or improvements when their review or assessment identifies deficiencies in a proposal, program, practice, procedure, equipment, record or report;
(k) recommend measures or improvements to prevent recurrences of any incidents that exposed persons to unnecessary radiation, or to prevent recurrence of any other unusual incidents involving radioactive materials;
(l) advise managers of any need for additional resources to establish, maintain or improve radiation protection programs; and
(m) maintain written records of their activities, decisions, advice and recommendations concerning radiation safety, including details of meetings and reviews of data, reports, programs, procedures, circumstances, incidents or unusual occurrences.

3.4 Qualifications and duties of Radiation Safety Officers

RSOs are specialists who provide day-to-day administration and control of radiation protection programs on behalf of their employers. The qualifications required of RSOs in specific situations vary according to assigned responsibilities, and the magnitude, complexity or diversity of the associated uses of radioactive materials. Accordingly, in all

situations, the RSO should possess an appropriate combination of relevant work experience and formal training in assuring radiation safety.

Typically, RSOs who are assigned lead responsibility to ensure radiation safety at educational, medical and research institutions should have at least three years of relevant practical work experience. RSOs who are assigned similar responsibilities at institutions that engage in larger-scale or more complex uses of nuclear substances may require additional qualifications, as normally attained through advanced training and more experience.

RSOs should understand methods and technology to control, use, handle, store and dispose of the radioactive materials, and to monitor and control radioactive contamination, radiation fields and radiation exposures. They should also understand pertinent regulatory processes and requirements, such as relevant legislation and licence conditions.

An RSO employed by an educational, medical or research institution may or may not be a member of any associated RSC. However, in institutions where both RSO and RSC functions exist, the parties should consult, cooperate and coordinate, in accordance with written terms of reference provided by managers, in matters that could have an impact on radiation safety.

To ensure radiation safety and compliance with regulatory requirements on behalf of managers, an RSO at an educational, medical or research institution that uses radioactive materials may need to:

(1) in conjunction with managers and the RSC, supervise, advise and consult regarding issues related to the institution's use of radioactive materials in accordance with legislation and any relevant conditions of AECB licences;
(2) prepare annual reports in accordance with conditions contained in any relevant licence issued to the institution by the AECB;
(3) review, either independently or in concert with the institution's RSC, requests for authorization to purchase or use radioactive materials in order to ensure that the proposed uses and locations of use are acceptable and comply with the institution's radiation protection program, relevant legislation, and licence conditions;
(4) authorize only those purchases and uses of radioactive materials, and those work procedures, and conditions and locations of use, that assure compliance with the institution's radiation protection program, relevant legislation, and licence conditions;
(5) assess the proposed use of radioactive materials in laboratories, and designate laboratories for the use of radioactive materials [Reference 7];

(6) maintain a record of the status of all designated laboratories that use radioactive materials;
(7) develop and implement administrative controls or procedures to ensure radiation safety and compliance with regulatory requirements;
(8) assess the qualifications and competence of persons who apply to use or handle radioactive materials, to determine whether they can do so safely and in compliance with relevant legislation and licences;
(9) ensure that radiation protection programs appropriate to the organization's undertakings are developed, implemented and maintained;
(10) ensure that persons who are required to use or handle radioactive materials are adequately trained in radiation safety matters and compliance with the institution's radiation safety procedures;
(11) authorize qualified persons to possess, use or handle radioactive materials in accordance with the institution's policies and relevant legislation, procedures and licences;
(12) authorize the disposal of radioactive materials in accordance with legislation, the AECB licence, and the institution's policies and procedures;
(13) designate Atomic Radiation Workers (ARWs) in accordance with section 17 of the *AEC Regulations*;
(14) assess, independently or in conjunction with managers or the RSC, the effectiveness of radiation protection programs;
(15) ensure that persons who may be exposed to radiation in the course of their duties (such as porters, cleaners, secretaries, shippers and receivers) receive appropriate training in radiation safety matters;
(16) develop and implement programs to inspect and critically review the conduct of licensed activities, the adequacy of locations and facilities where radioactive materials are used and stored, and the adequacy of personnel training and safety procedures;
(17) implement remedial actions to correct any deficiencies identified in the inspection programs referred to (16) above;
(18) initiate revisions to procedures, changes to equipment and facilities, and amendments to AECB licences to ensure that the institution's operations, equipment and facilities remain in compliance with regulatory requirements;
(19) communicate with managers, the RSC, and users of radioactive materials on matters relevant to radiation safety;
(20) design and implement, in accordance with regulatory requirements, appropriate personnel monitoring and bioassay programs to measure "external" and "internal" exposures to ionizing radiation;
(21) administer or control the issue, use and maintenance of radiation monitoring devices and equipment within the institution, and the recording of results;

(22) monitor the occupational radiation exposures received by persons by reviewing, at least quarterly, their records of exposures;
(23) where the above reviews of radiation exposure records indicate that exposures are unnecessarily high, recommend to managers measures to reduce these exposures in accordance with the ALARA principle of dose limitation [Reference 5];
(24) investigate reports of overexposures to ionizing radiation, of accidents involving radioactive materials, and of losses of radioactive materials in order to confirm or determine pertinent facts;
(25) recommend appropriate actions to mitigate the consequences of, or to prevent the recurrence of, overexposures to ionizing radiation, accidents involving radioactive materials or losses of radioactive materials;
(26) ensure that the incidents referred to in (24) above, and the results of related investigations, are reported to the AECB and other relevant authorities in accordance with legislation and the licence issued to the institution;
(27) assess the adequacy of survey programs for measuring or managing radiation fields and radioactive contamination during licensed activities, such as during the use, storage and disposal of radioactive materials;
(28) ensure that the results of programs to reduce or remove radioactive contamination meet regulatory requirements;
(29) ensure that sealed radiation sources are leak-tested in accordance with the institution's procedures and regulatory requirements [Reference 8];
(30) ensure that all persons who use or handle radioactive materials follow approved procedures, in order to prevent occupational exposures to ionizing radiation that exceed regulatory limits or violate the ALARA principle of dose limitation;
(31) when an AECB licence authorizes the use of radioactive materials in research, diagnosis or therapy on humans, consult, communicate or cooperate with the responsible physician or internal authority (such as a scientific or ethical review committee) as necessary to assure the safe use of radioactive materials and compliance with licence conditions and regulations;
(32) prepare or review proposed or existing radiation safety procedures, either independently or in cooperation with the RSC;
(33) coordinate, or participate in, emergency responses to accidents involving radioactive materials;
(34) ensure that records and reports that are required of the institution by legislation and licences are prepared, maintained or submitted as required; and
(35) ensure that any radioactive materials that are to be transported are packaged for transport in accordance with regulations [Reference 4].

4. Facilities and equipment

4.1 General

To assure radiation safety at educational, medical and research institutions, managers should provide essential facilities and equipment. These typically include a properly designed workplace as well as appropriate personnel safety, radiation monitoring and emergency response equipment. These provisions must be selected, designed, constructed, operated or maintained so as to ensure radiation safety while accommodating work activities.

Before approving the use of equipment or facilities, managers should ensure that the institution's RSO, RSC or other specialists assess and confirm their adequacy with respect to radiation safety.

Regulatory requirements or advice concerning designated laboratories, protective equipment, radiation monitoring equipment or related matters may be expressed in legislation, licences or regulatory documents, as discussed below.

4.2 Designing and designating laboratories

Information regarding the licensing of laboratories that use radioactive materials is typically expressed in regulatory documents, such as regulatory standards, guides or notices. In particular:

(a) Licences issued by the AECB to educational, medical and research institutions may require their respective holders to classify (i.e., "designate") their laboratories that use radioactive materials, on the basis of criteria that relate to the form and quantities of radioactive materials to be used, and not to the quantities of radioactive materials stored or possessed.
(b) Licences issued by the AECB to educational, medical and research institutions may further require the construction or renovation of designated laboratories to comply with standards specified in regulatory documents [for example, Reference 7].
(c) Licences issued by the AECB to educational, medical and research institutions may stipulate that the design of a designated laboratory must be approved in writing by the AECB, and/or that the designated laboratory must be inspected by the AECB before radioactive materials may be used in the laboratory [Reference 9].

4.3 Measuring and limiting radiation

Educational, medical and research institutions may use radiation monitoring programs, and protective equipment and clothing, to assess, assure or demonstrate radiation safety.

These uses are discussed below.

4.3.1 Safety equipment

Educational, medical and research institutions that use radioactive materials should ensure that their staff and workers have access to, or are equipped with, any personnel safety equipment that is necessary to limit radiation exposures in accordance with the ALARA principle, regulatory dose limits and corporate procedures. Work trays, bench shields, syringe shields and lead aprons are examples of common personnel safety measures.

Since safety equipment needs may vary or fluctuate according to case-specific circumstances, RSOs should review their institution's proposed or in-place personnel safety measures to determine or confirm whether these procedures are or remain adequate.

4.3.2 Emergency supplies

Educational, medical and research institutions that use radioactive materials should provide appropriate supplies for use in emergencies that involve radiation or radioactive materials. To help ensure that the affected persons will be able to use these supplies and equipment effectively in the event of an emergency, institutions should develop any necessary user procedures, and should train key personnel in the use of emergency supplies in accordance with these procedures.

Since the probability and severity of accidents depend upon case-specific circumstances, individual licensees should ensure that credible estimates of the types and quantities of emergency supplies and equipment required for their respective situations are made. These determinations, which should take into account the probability and severity of potential emergencies, should be based on credible data and experience, such as that of the institution and industry.

The supplies to be provided for use in emergencies should be commensurate with the anticipated radiation hazards. For example, at facilities and locations where unsealed radioactive materials are used, emergency supplies may be needed to absorb, clean up, or otherwise limit, control or mitigate the consequences of spills of radioactive materials or radioactive contamination of persons or property. Special precautions could be warranted in some cases, such as the provision of equipment to remove contamination. In less hazardous situations, basic first-aid and emergency supplies may suffice.

4.3.3 Monitoring provisions

Radiation measurements are essential in order to assess, verify or demonstrate the credibility and effectiveness of an institution's radiation protection program.

To be useful, radiation detection and monitoring equipment must be correctly calibrated, operated and maintained. The equipment may be fixed or portable, automated or manual, multi-purpose or single-purpose. For example, portable survey instruments may be used to assess or confirm radiation fields at different locations, or over large areas. Both fixed monitors and portable instruments may be needed to detect or assess radioactive contamination of equipment, premises or persons. Personal dosimeters, air samplers or environmental monitors may be necessary to measure, estimate or control worker exposures or radioactive releases to the environment.

Educational, medical and research institutions should ensure that properly calibrated equipment of appropriate design and function are conveniently available for use at laboratories and other locations where radioactive materials are stored, handled or used. The quantities and types of radiation monitoring equipment needed in a specific situation will depend on such factors as the type, forms, location, association, magnitude and extent of the subject radiation. For example, the required radiation measurement could relate to surface contamination, radiation fields, personnel exposures, or radioactive releases to water or air.

Monitoring instruments or installations should be provided in sufficient types and numbers to accommodate the anticipated user demand. For example, although a single radiation detector or a single type of radiation detector might suffice for limited contamination monitoring, it might not be acceptable or adequate for dose-rate measurements. Conversely, although a particular survey meter or type of survey meter might suffice for the required dose-rate measurements, it might not be capable of detecting or measuring any or all surface contamination.

Institutions should ensure that the radiation monitoring equipment they provide for use with respect to their facilities is calibrated, serviced and operated in accordance with manufacturers' recommendations, licence conditions, and any other relevant regulatory requirements [Reference 10].

5. Radiation safety procedures

5.1 General

An application for a licence to use radioactive materials in education, medicine or research should include, for regulatory consideration, a description of the measures that the institution proposes to implement to ensure the safe use of radioactive materials.

Since radiation safety pr[illegible]edures are an essential element of all radiation protection programs, the above applic[illegible]tion should describe the procedures that the applicant proposes to implement to ensure radiation safety during the proposed activities.

Radiation safety procedures help affected persons, such as staff and workers, proceed safely in specific situations and related undertakings. Accordingly, procedures that are important to radiation safety at educational, medical and research institutions should be correct, complete and unambiguous. If radiation safety procedures are properly conceived, written, communicated, and administered, users should be able to understand and implement them without undue difficulty.

5.2 Developing and administering radiation safety procedures

To be effective, radiation safety procedures at educational, medical and research institutions must be appropriate and well administered. The administration aspect encompasses implementation, maintenance and enforcement functions. Accordingly, managers, staff and workers must cooperate closely to develop appropriate radiation safety procedures, and to implement and administer them effectively.

When developing their radiation safety procedures, institutions should involve or consult qualified radiation safety specialists and primary stakeholders. These participants could be employees, external advisors or contractors, including RSOs, members of RSCs or professional consultants.

To expedite and encourage the timely development, implementation and maintenance of adequate radiation safety procedures, the institution's radiation safety specialist(s) should be involved in the early stages. In particular, the specialist(s) should confirm the adequacy of the institution's radiation safety procedures before they are submitted by managers for regulatory review and approval. In addition to encouraging early consideration of radiation safety, this precaution may avoid licensing delays due to inadequate radiation safety procedures or documentation.

The development, implementation and maintenance of radiation safety procedures at educational, medical and research institutions is necessarily dynamic and ongoing. As

work activities or responsibilities change, the institutions will need to update — revise, withdraw or replace — their procedures accordingly.

To ensure that an institution's radiation safety procedures remain adequate and up-to-date, the RSO should monitor their status and related matters closely. This overview should include formal reviews by the RSO at approximately two-year intervals, or in response to significant changes in the institution's licensed activities. If significant changes in work activities occur, or deficiencies in existing procedures are detected, the RSO should immediately bring these to the attention of managers and seek corrective changes forthwith.

To be useful, radiation safety procedures must be communicated effectively to those affected. Radiation safety specialists, with the support of their managers, should ensure that the institution's staff and workers understand those procedures that could affect them. This understanding may be achieved, in some cases, by proper circulation of well-written instructions. In other situations, it may be necessary to provide additional clarifications, such as those normally accomplished by classroom instruction or workplace training. The RSO, RSC or the institution's managers should periodically assess the success of these efforts. If the results of these assessments indicate that the communication or training has not been effective, the responsible person(s) should determine the cause and propose corrective measures.

5.3 Content of radiation safety procedures

5.3.1 General

Since the radiation safety procedures of educational, medical and research institutions are typically developed to suit the respective needs, circumstances and preferences, they will vary accordingly. However, to assure radiation safety and general compliance with relevant requirements, applicants for licences should typically include procedures that describe how the institution proposes to:

- designate and design laboratories
- ensure that persons are appropriately trained and adequately qualified in radiation safety
- conduct licensed activities safely
- prevent the spread of radioactive contamination
- control (purchase, maintain, receive) inventories of radioactive materials
- secure radioactive materials
- post warning signs and licences

- assess, measure and detect radiation fields, radioactive contamination and radiation exposures
- calibrate radiation survey and monitoring equipment
- determine whether radioactive sources leak
- package and transport radioactive materials
- cope with emergencies
- decommission facilities, equipment or premises
- transfer or dispose of radioactive wastes
- report information and keep records

The following sections provide additional guidance as to the information to be included.

5.3.2 Specific

(a) Designing and designating laboratories

These procedures should describe how new and renovated laboratories are to be designed and designated in accordance with applicable licences, and should require that AECB approvals be obtained prior to the use of radioactive materials in these laboratories, where such approvals are required by the licence or law.

(b) Ensuring that users of radioactive materials are trained and qualified

An educational, medical or research institution's radiation protection program should include procedures that:

- authorize only adequately qualified persons to work with radioactive materials, and define the qualifications required by those persons;
- require that persons who may be exposed to ionizing radiation as a consequence of the institution's use of radioactive materials be instructed in advance regarding related radiation hazards and appropriate radiation safety procedures;
- require that persons who work with radioactive materials, or persons who may be exposed to ionizing radiation as a consequence of the institution's use of radioactive materials, are informed of any pertinent changes in radiation hazards, AECB licence conditions, or regulations; and
- require records of the particulars (dates, content, attendees) of any training in radiation safety given to persons.

(c) Controlling inventories of radioactive materials

An educational, medical or research institution's radiation protection program should include procedures to effectively control inventories of radioactive materials in the interests of radiation safety.

These procedures should address the ordering, purchasing, receiving, monitoring, handling, securing, controlling, storing, maintaining, recording, documenting, and transferring of deliveries or inventories of radioactive materials, or devices containing radioactive materials. The procedures should clearly and expressly indicate to handlers and users what they are to do, how they are to proceed, which criteria or other procedures they are to apply or obey, and what approvals or authorizations are required, and from whom. Those affected by the procedures need to know who must "approve," "authorize," "secure," etc., in accordance with which specific procedures or standards.

Such procedures typically require that responsible persons:

- order or use only devices containing radioactive materials that have been approved by the AECB for use in Canada;
- review each proposed purchase of radioactive materials or devices containing radioactive materials to ensure that the purchase:
  - has been properly authorized in accordance with institution procedures,
  - will not cause the possession limits stated in a licence to be exceeded, and
  - will not cause the activity limits for individual radioactive sources, as stated in a licence, to be exceeded;
- maintain accurate, up-to-date records in writing of the types and quantities of radioactive materials purchased, the dates and locations of their delivery, and the particulars of their subsequent handling, use and disposal; and make these records available at the locations where the associated materials are stored or used;
- if appropriately trained in radiation safety and related handling procedures, including methods to limit radioactive contamination as a consequence of damaged shipments, receive deliveries of radioactive materials or devices containing radioactive materials in accordance with institution procedures;
- upon receiving deliveries of radioactive materials or devices containing radioactive materials, visually inspect the packaging to detect any obvious damage;

- when deliveries of radioactive materials or devices containing radioactive materials are received during normal working hours, transfer these deliveries, forthwith, to an authorized location and monitor the exterior of the packaging to detect any removable radioactive contamination;
- ensure that radioactive materials and devices containing radioactive materials, when delivered outside of the institution's normal working hours, are received and stored in accordance with procedures designed to prevent unnecessary exposure of persons to radiation; and
- if authorized to do so, identify and open packages containing radioactive materials or devices containing radioactive materials in accordance with the AECB guidance and any applicable institution procedures.

(d) Securing radioactive materials

Radiation protection programs at educational, medical and research facilities should include provisions to prevent unauthorized use of radioactive materials, or deliberate or accidental access to such materials. For example, radiation safety or operating procedures typically permit only authorized persons to access radioactive materials in accordance with complementary physical and administrative arrangements that secure, and restrict the use of, such materials. Such arrangements often require that radioactive materials, when unattended by authorized persons, must be stored in locked containers or rooms to discourage theft, unauthorized use or inadvertent exposures to radiation.

Educational, medical and research institutions should ensure that persons under their control who are required to use radioactive materials are instructed in their obligations with respect to the physical security of radioactive materials.

(e) Posting licences and radiation warning signs

An educational, medical or research institution's safety procedures should require that responsible persons:

- post copies of the institution's regulatory licence at conspicuous locations in accordance with licences and legislation;
- make a copy of the licence available at all locations where radioactive materials, or devices containing radioactive materials, are used or stored; and

- post "Radiation Warning" signs as required by legislation, licence conditions and the institution's procedures.

(f) Conducting licensed activities

An educational, medical or research institution's radiation protection program should ensure that radioactive materials and devices containing radioactive materials are used safely during licensed activities. Guidance for the use of radioactive materials in designated laboratories is contained in AECB regulatory documents [References 12, 13].

(g) Preventing the occurrence and spread of contamination

An educational, medical or research institution's radiation protection program should include procedures to:

- minimize the occurrence of radioactive contamination
- prevent significant spread of radioactive contamination
- define when and how radioactive contamination is to be detected and measured
- describe the corrective actions to be taken if radioactive contamination occurs [Reference 15]

(h) Monitoring

Radiation monitoring provisions are an important aspect of radiation safety programs at educational, medical and research institutions. If the institution's activities involve significant quantities of radioactive materials, involve a significant possibility or probability of radioactive exposure or contamination, or involve other justifications, monitoring may be necessary to assure or demonstrate safety or compliance with regulatory criteria [Reference 14].

Typically, monitoring programs at educational, medical or research institutions assess and document radiation fields, detect and measure radioactive contamination of surfaces, record the radiation doses received by workers or measure radioactive releases to the environment. The associated laboratories that use, or propose to use, radioactive materials should evaluate their monitoring requirements, and should develop appropriate programs and procedures [References 10, 15]. Procedures are normally required for the measurement of radiation fields, contamination, and doses to workers. Environmental monitoring programs and procedures are required in situations where there are significant releases to the environment.

(i) Testing sealed sources for leakage

Radiation protection programs at educational, medical and research institutions should include procedures that document when and how sealed radioactive sources are to be tested for leakage. These procedures should indicate whether the tests are to be conducted by the licensee or by a contractor, and should be guided by any relevant regulatory documents [Reference 8].

(j) Transporting radioactive materials and packaging radioactive materials for transport

If radioactive materials or devices containing radioactive materials are to be transported in the public domain, they must be packaged in accordance with relevant legislation. Accordingly, educational, medical or research institutions that consign radioactive materials for transport beyond their premises should do so in accordance with written procedures that document how they will satisfy any applicable transport and transport-packaging requirements [Reference 4].

(k) Planning for emergencies

Radiation protection programs at educational, medical and research institutions should include general or specific emergency response procedures that define how persons should react if involved in accidents or emergencies involving radiation or radioactive material.

Response procedures are necessary for all realistic accident scenarios. These procedures should address such topics as the effects on persons (e.g., radioactive contamination, injuries such as cuts and needle punctures, chemical hazards or danger of infection) containment of spills, cleanups of spills, and prevention or control of fire [Reference 16].

(l) Decommissioning

Educational, medical and research institutions that use radioactive materials must decommission their licensed facilities, equipment or premises to the satisfaction of the AECB in accordance with regulatory requirements. Such decommissioning must be completed satisfactorily as a prerequisite to regulatory approval to abandon. Guidance on decommissioning is provided in regulatory documents [References 17,18].

(m) Managing radioactive wastes

The radiation safety or operating procedures of an educational, medical or research institution should define in detail how the institution will handle and dispose of radioactive materials that are considered to be wastes.

Educational, medical and research institutions typically dispose of relatively short-lived radioactive material using a "delay-and-decay" approach. This approach consists of secure short-term storage of radioactive material until its radioactivity has decayed to the extent that it may be considered "non-radioactive" [Reference 19]. Non-radioactive material may be released to the environment, to a conventional landfill facility, or to a commercial chemical waste facility, depending upon specific circumstances and regulatory requirements [Reference 20].

Alternatively, educational, medical and research institutions normally dispose of wastes that remain significantly radioactive over long periods of time by transfer to a licensed radioactive waste management facility.

(n) Reporting and record-keeping

Educational, medical and research institutions that use radioactive materials should ensure, through appropriate administrative arrangements, that the information they need to prepare the reports required by procedures, legislation and licences is collected, that accurate and complete records are maintained, and that reports are prepared and submitted as required.

REFERENCES

1. Canada. Advisory Committee on Radiological Protection, *ACRP-16: Elements of a Radiation Protection Program for Medical and Academic Institution.*, Ottawa: Atomic Energy Control Board, 1997. AECB document INFO-0685.

2. Canada. Advisory Committee on Radiological Protection, *ACRP-15: The Management of Workers Occupationally Exposed to Ionizing Radiation.* Ottawa: Atomic Energy Control Board, 1993. AECB document INFO-0484.

3. Canada. Atomic Energy Control Board, *Atomic Energy Control Regulations.* Ottawa: Atomic Energy Control Board, [1992]. Office Consolidation with amendments to August 27, 1992.

4. Canada. Atomic Energy Control Board, *Transport Packaging of Radioactive Materials.* Ottawa: Atomic Energy Control Board, [1992]. Office Consolidation with amendments to February 27, 1992.

5. Canada. Atomic Energy Control Board, *Guidelines on How to Meet the Requirement to Keep All Exposures as Low as Reasonably Achievable.* Ottawa: Atomic Energy Control Board, 1997. Regulatory Guide G-129(E).

6. Canada. Atomic Energy Control Board, *Radiation Safety Training For Radioisotope, Medical, Accelerator and Transportation Workers.* Ottawa: Atomic Energy Control Board, 1998. Consultative Document C-200(E).

7. Canada. Atomic Energy Control Board, *Design Guide for Basic and Intermediate Level Radioisotope Laboratories.* Ottawa: Atomic Energy Control Board, 1991. Regulatory Document R-52 /Revision 1.

8. Canada. Atomic Energy Control Board, *Requirements for Leak Testing Selected Sealed Radiation Sources.* Ottawa: Atomic Energy Control Board, 1995. Regulatory Document R-116.

9. Canada. Atomic Energy Control Board, *New Policy on Design Compliance Approval for Radioisotope Laboratories.* Ottawa: Atomic Energy Control Board, 1996. Notice 96-02.

10. Canada. Atomic Energy Control Board, *Requirements for Gamma Radiation Survey Meter Calibration.* Ottawa: Atomic Energy Control Board, 1995. Regulatory Document R-117.

11. Canada. Atomic Energy Control Board, *Radioisotope Safety: Identifying and Opening Radioactive Packages*. Ottawa: Atomic Energy Control Board, 1996. Document INFO-0426/Revision 1 (poster).

12. Canada. Atomic Energy Control Board, *Radioisotope Safety: Basic Laboratories*. Ottawa: Atomic Energy Control Board, 1997. Document INFO-0141/Revision 3 (poster).

13. Canada. Atomic Energy Control Board, *Radioisotope Safety: Intermediate Laboratories*. Ottawa: Atomic Energy Control Board, 1997. Document INFO-0142/Revision 3 (poster).

14. Canada. Atomic Energy Control Board, *Monitoring and Dose Recording for the Individual*. Ottawa: Atomic Energy Control Board, 1990. Regulatory Document R-91.

15. Canada. Atomic Energy Control Board, *Radioisotope Safety: Monitoring for Radioactive Contamination*. Ottawa: Atomic Energy Control Board, 1995. Document INFO-0545.

16. Canada. Atomic Energy Control Board, *Radioisotope Safety: Spill Procedures*. Ottawa: Atomic Energy Control Board, 1994. Document INFO-0534 (poster).

17. Canada. Atomic Energy Control Board, *Policy on the Decommissioning of Nuclear Facilities*, Ottawa: Atomic Energy Control Board, 1988. Regulatory Document R-90.

18. Canada. Atomic Energy Control Board, *Decommissioning Planning Guide for Licensed Activities*. Ottawa: Atomic Energy Control Board, 1998. Consultative Document C-219(E).

19. Canada. Atomic Energy Control Board, *Radiation Safety Requisites for the Exemption of Certain Radioactive Materials From Further Licensing Upon Transferral for Disposal*. Ottawa: Atomic Energy Control Board, 1989. Regulatory Document R-85.

20. Canada. Atomic Energy Control Board, *Regulatory Objectives, Requirements and Guidelines for the Disposal of Radioactive Wastes - Long-term Aspects*. Ottawa: Atomic Energy Control Board, 1987. Regulatory Document R-104.